



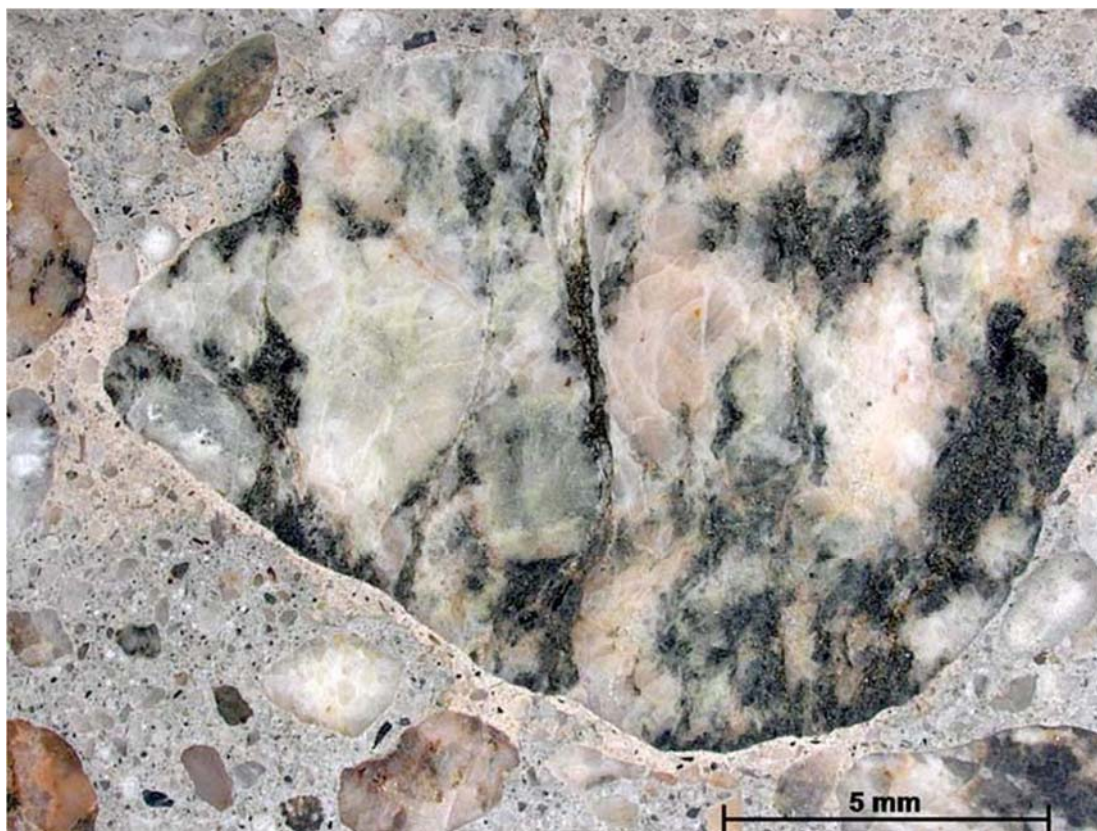
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Petrographic Analysis of Cores from Plant 42

E. Rae Reed-Gore, Kyle Klaus, and Robert D. Moser

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Preface

This study was conducted in support of the US-AFCEC. The 13 cores, from Air Force Plant 42, were logged in as CMB No. 160143-1 to 160143-13, were subjected to an in-depth analysis consisting of visual and petrographic examination. The technical monitor was Dr. Robert D. Moser of the U.S. Army Engineer Research and Development (ERDC).

The work was performed by the Concrete and Materials Branch (GMC), of the Engineering Systems and Materials Division (GM), US Army Engineer Research and Development Center (ERDC), Geotechnical and Structures Laboratory (ERDC-GSL). At the time of publication, Christopher M. Moore was Chief, CEERD-GMC; Dr. Gordon W. McMahon was Chief, CEERD-GM. The Deputy Director of ERDC-GSL was Dr. William P. Grogan and the Director was Mr. Bart Durst.

COL Bryan Green was the Commander of ERDC, and Dr. Jeffery P. Holland was the Director.

1 Scope

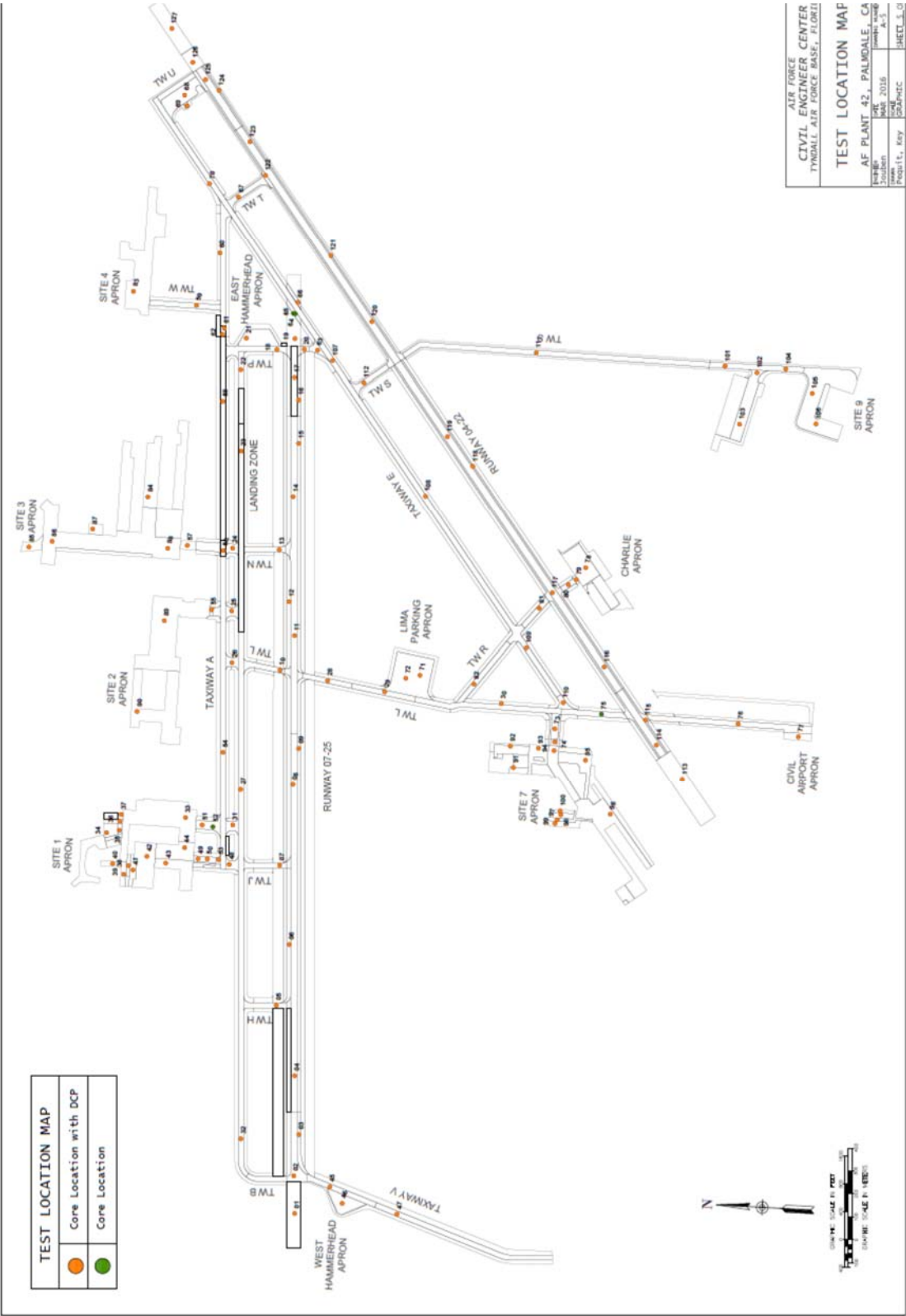
The Concrete and Materials Branch (CMB) of the Geotechnical and Structures Laboratory was requested to perform an analysis on concrete core samples extracted from Air Force Plant 42. A total of 13 cores were provided to the CMB which were checked in under CMB Serial Numbers 160143-1 to 160143-13. Table 1 lists the cores received with the CMB serial number, original sample identifier, section sample came from, and core length. Each core underwent petrographic examination according to ASTM C-856. Scanning electron microscopy (SEM) imaging, was performed on a samples to identify material in voids. The location of the extracted core locations can be seen in Figure 1.

The following sections provide a summary of the methods utilized, results obtained from each core, and a summary of observed condition of cores for the site investigated.

Table 1. Summary of cores received, corresponding CMB Serial No, core number from site, section sample came from, and core length.

CMB ID	Core #	Section	Core Length (in)
160143-1	02T	R01A	8.5
160143-2	04T	R03C	8.75
160143-3	05T	T03A	9.75
160143-4	08T	803C	9.5
160143-5	11T	R14C	6.5
160143-6	13T	T14A	6.75
160143-7	25T	T06A	7.5
160143-8	28	T33A	9.875
160143-9	54T	T07A	6.75
160143-10	56T	T35A	9.5
160143-11	78T	A13B	6.75
160143-12	120T	R13C	7.75
160143-13	123T	R13C	6.625

Figure 1. Test location map of AF Plant 42 with core number locations.



2 Methods

Testing was conducted to determine the mineralogical constituents of the concrete and any possible chemical reactions and microstructural deterioration present. The following describes the methods utilized.

2.1 Petrographic Analysis

Modes of distress such as sulfate attack, microcracking, and overall concrete quality were assessed by visual examination of the as received cores as well as a petrographic analysis performed on polished cross sections conducted according to ASTM C856 - Standard Practice for Petrographic Examination of Hardened Concrete. A 25 mm thick section of a core was cut and prepared for the petrographic analysis. The section for petrographic analysis was polished using diamond incrustated polishing pads. The polished sample was imaged using a Zeiss Stereo Discovery V20 microscope at magnifications of 5 X to 40 X. An overall image was obtained for the sample at low magnification, and at least three selected sites were also imaged at higher magnification. Specific focus was given to microcracking, air void structure, aggregate deterioration, and any other possible modes of concrete deterioration that are relevant for service life estimation.

2.2 Scanning Electron Microscopy (SEM)

A specimen was examined using scanning electron microscopy (SEM) to obtain high-resolution image to examine the deposits within an air void to determine the crystallinity of the deposit. SEM imaging was performed using an FEI Nova NanoSEM 630, capable of high-resolution imaging on non-conductive materials. Imaging was performed in low-vacuum mode at pressures of 0.1-0.5 mbar and accelerating voltage of 15kV.

3 Results and Discussion

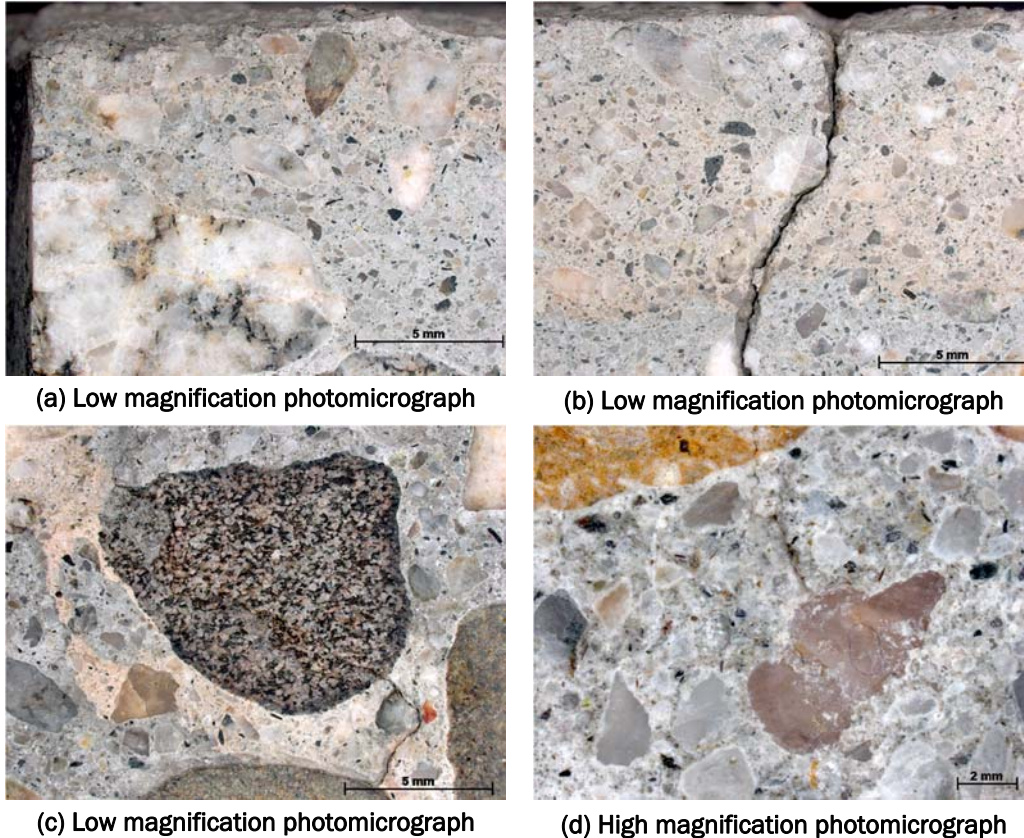
3.1 Core Sample 160143-1 (O2T)

The as-received core 160143-1 (O2T) is shown in Figure 2. The core was 8.5 inches long and 6 inches in diameter. There were 2 cracks greater than 0.5mm in width, one extends 3 in into core, extends through 2 coarse aggregates and terminates at a coarse aggregate. The second crack extends 3.5 in into core, extends around 1 coarse aggregate, but through 4 others. Carbonation staining is within the top inch from the surface. There was some staining along the longer crack, indicating the crack was most likely a shrinkage crack from construction. There was minor aggregate distress observed, but no severe ASR deterioration observed. See Figure 3 for low and high magnification microscopy images of 160143-1 (O2T).

Figure 2. The as-received core 160143-1 (O2T).



Figure 3. Low and High magnifications of 160143-1 (O2T). (a) minor carbonation staining at the surface, (b) carbonation staining and crack at the surface, (c) carbonation staining around cracked aggregate, (d) high magnification to see fine aggregate and cement, minor cracking.



3.2 Core Sample 160143-2 (O4T)

The as-received core 160143-2 (O4T) is shown in Figure 4. The core was 8.75 inches long and 6 inches in diameter. A crack over 2 in into concrete, greater than 0.5mm width, extends through 2 coarse aggregates and terminates at a coarse aggregate. Carbonation staining is within the top inch from the surface, mainly around aggregates. There was some staining along the longer crack, indicating the crack was most likely a shrinkage crack from construction. Air voids are infilled with precipitates (ettringite and calcium hydroxide). A void, seen in Figure 5 (b), appears to be from an aggregate that popped out earlier or from a large entrapped air void

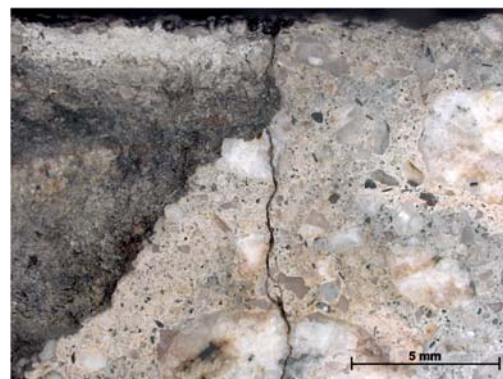
Figure 4. The as-received core 160143-2 (04T).



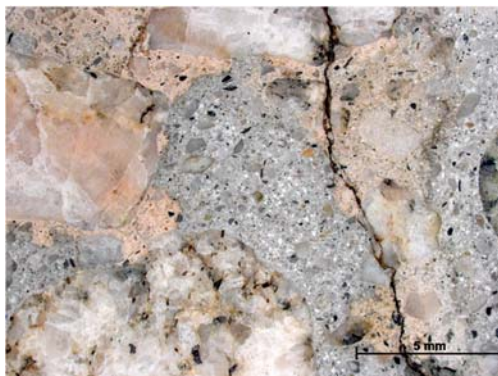
Figure 5. Low and High magnifications of 160143-2 (04T). (a) carbination sataining at the surface, (b) carbination stainging, crack at the surface, and large void most likely due to aggregate pop out, (c) carbination staining around cracked aggregate, (d) high magnification to see fine aggregate and cement, minir cracking.



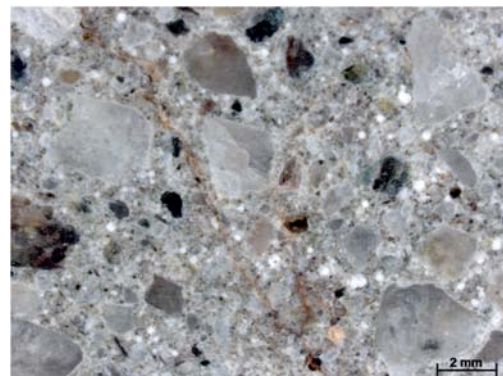
(a) Low magnification photomicrograph



(b) Low magnification photomicrograph



(c) Low magnification photomicrograph



(d) High magnification photomicrograph

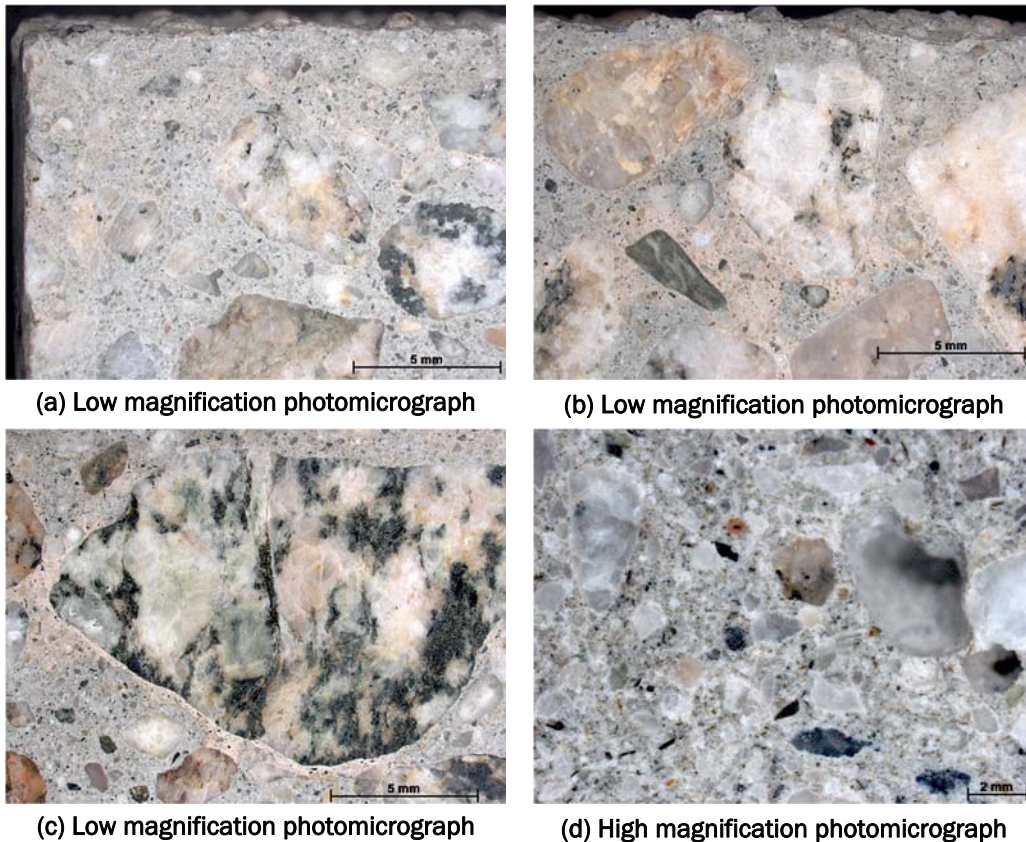
3.3 Core Sample 160143-3 (05T)

The as-received core 160143-3 (05T) is shown in Figure 6. The core was 9.75 inches long and 6 inches in diameter. There was minor carbonation staining within an inch of the surface. A crack was observed to extend 3mm, was less than 0.1 mm width and terminates at a coarse aggregate. Some crack was observed in the coarse aggregate of which followed the foliated fabric of the aggregate. Voids were partially infilled with a white deposit, most likely ettringite and calcium hydroxide. See Figure 7 for low and high magnification microscopy images of 160143-1 (02T).

Figure 6. The as-received core 160143-3 (05T).



Figure 7. Low and High magnifications of 160143-3 (05T). (a) minor carbonation staining at the surface, (b) carbonation staining at the surface, (c) carbonation staining around cracked aggregate, (d) high magnification to see fine aggregate and cement.



3.4 Core Sample 160143-4 (08T)

The as-received core 160143-4 (08T) is shown in Figure 8. The core was 9.5 inches long and 6 inches in diameter. The large vertical crack in as-received core caused sample to separate upon cutting core. The crack did not appear to go through any coarse aggregates. Minor carbonation staining within an inch of the surface was observed. There was no visible signs of ASR gel or damage due to ASR gel expansion. Voids were partially infilled with a white deposit, most likely ettringite and calcium hydroxide. See Figure 9 for low and high magnification microscopy images of 160143-4 (08T).

Figure 8. The as-received core 160143-4 (O8T).

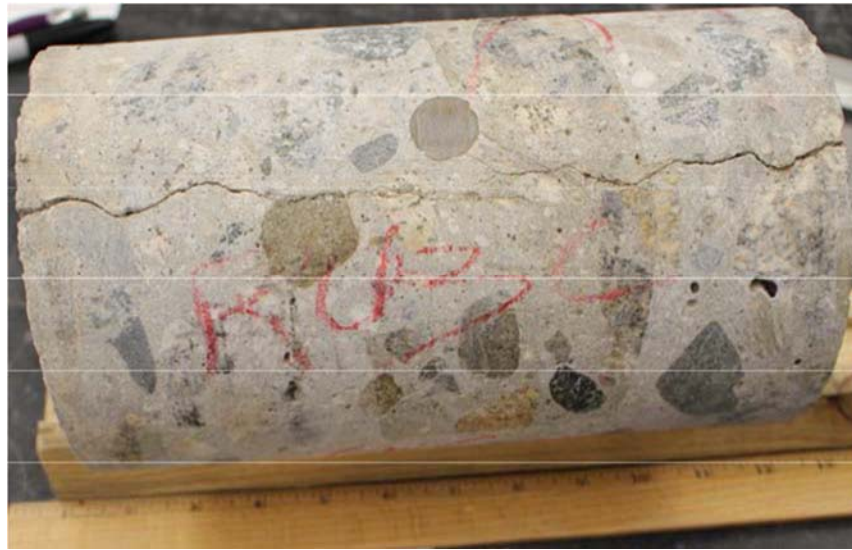
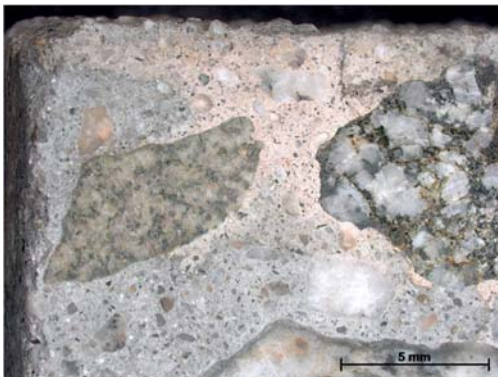


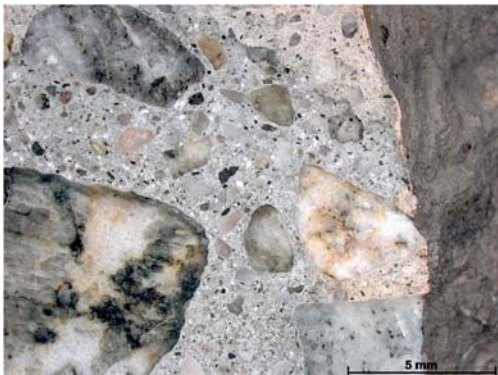
Figure 9. Low and High magnifications of 160143-4 (O8T). (a) minor carbination staining at the surface, (b) carbination staining at the surface, (c) carbination staining following preexisting crack, (d) high magnification to see fine aggregate and cement.



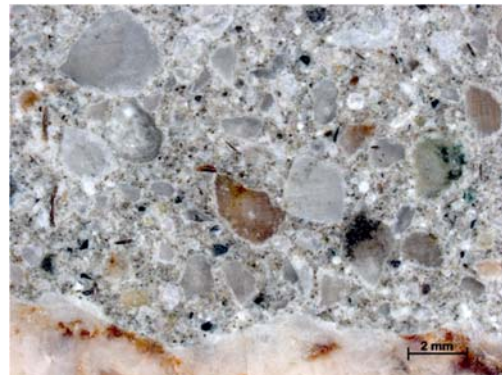
(a) Low magnification photomicrograph



(b) Low magnification photomicrograph



(c) Low magnification photomicrograph



(d) High magnification photomicrograph

3.5 Core Sample 160143-5 (11T)

The as-received core 160143-5 (11T) is shown in Figure 10. The core was 6.5 inches long and 6 inches in diameter. Very minor staining at surface is due to carbonation and deeper in sample oxidation of iron oxide inclusions in aggregates. Voids were partially infilled with a white deposit, most likely ettringite and calcium hydroxide. There were 2 vertical cracks observed, the first extended 20mm, greater than 0.2 mm wide and terminates in a coarse aggregate. The second crack extended 12mm and terminated at a coarse aggregate, and was greater than 0.1mm width. This sample contained large entrapped air voids (greatest was 3/8" x 1/4"). A coarse aggregate has cracking throughout the aggregate, cracks follow the foliation of the aggregate and does not appear to extend into paste. Some of the microcracks appear to be infilled with gel, evidence of minor ASR. See Figure 11 for low and high magnification microscopy images of 160143-5 (11T).

Figure 10. The as-received core 160143-5 (11T).

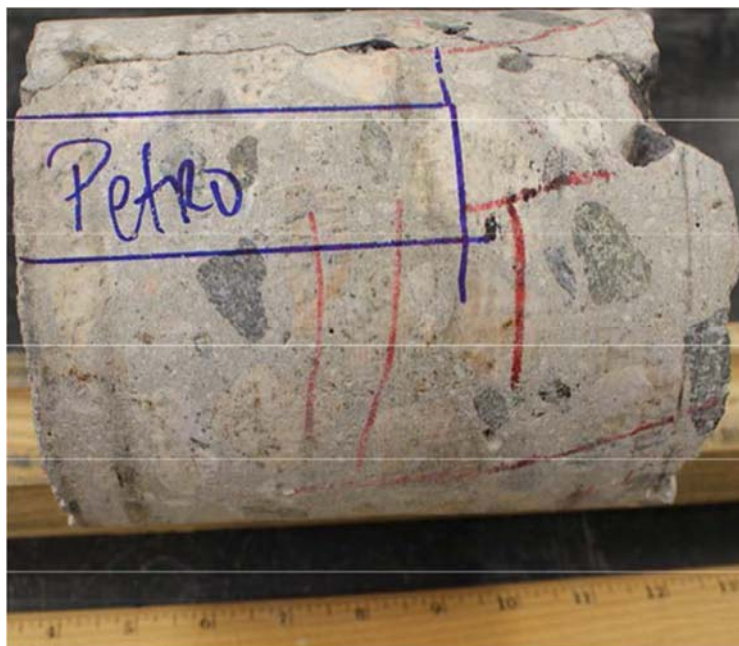
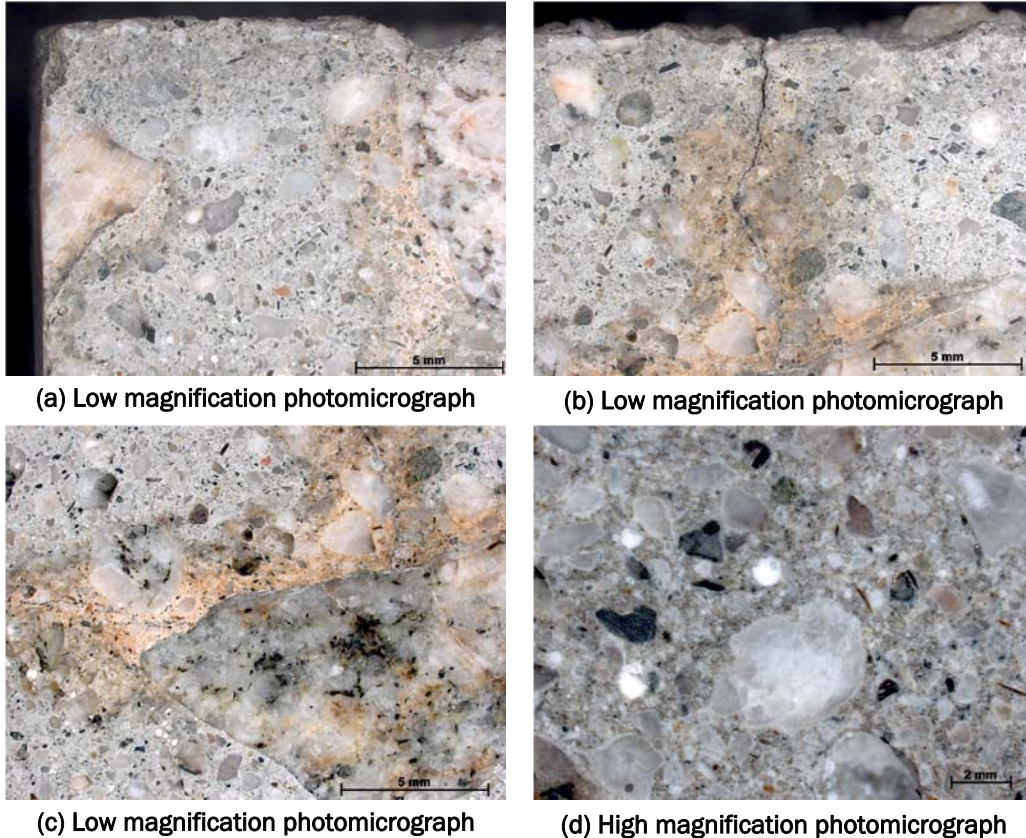


Figure 11. Low and High magnifications of 160143-5 (11T). (a) minor carbonation staining at the surface, (b) carbonation staining at the surface following older crack, (c) carbonation staining around coarse aggregate, (d) high magnification to see fine aggregate and cement.



3.6 Core Sample 160143-6 (13T)

The as-received core 160143-6 (13T) is shown in Figure 12. The core was 6.75 inches long and 6 inches in diameter. Minor carbonation staining within a half inch of the surface was observed. There was no visible signs of ASR gel or damage due to ASR gel expansion. Voids were partially in-filled with a white deposit, most likely ettringite and calcium hydroxide. A crack, 11mm deep and less than 0.1mm width, was observed. Carbonation staining was observed along this crack. See Figure 13 for low and high magnification microscopy images of 160143-6 (13T).

Figure 12. The as-received core 160143-6 (13T).

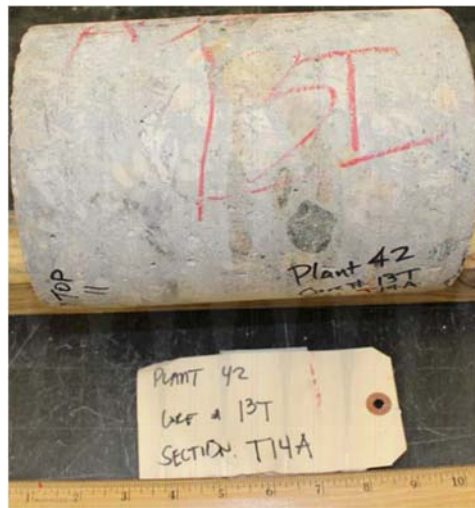
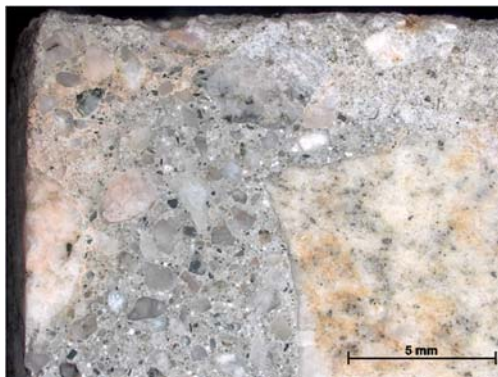
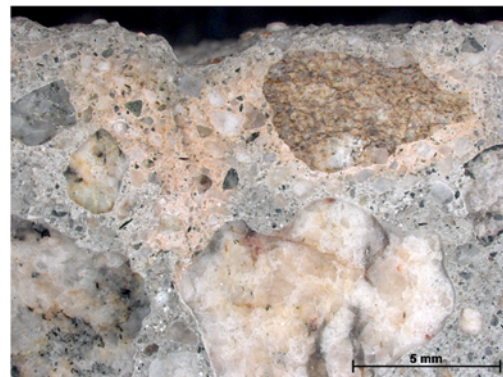


Figure 13. Low and High magnifications of 160143-6 (13T). (a) minor carbination staining at the surface, (b) carbination staining at the surface around coarse aggregates, (c) high magnification to see fine aggregate and cement.



(a) Low magnification photomicrograph



(b) Low magnification photomicrograph



(c) High magnification photomicrograph

3.7 Core Sample 160143-7 (25T)

The as-received core 160143-7 (25T) is shown in Figure 14. The core was 7.5 inches long and 6 inches in diameter. Minor carbonation staining within an inch of the surface was observed. There was no visible signs of ASR gel or damage due to ASR gel expansion. Voids were partially infilled with a white deposit, most likely ettringite and calcium hydroxide. A crack extends 45mm from the surface and was greater than 0.5mm width. The crack extended around 1 coarse aggregate, but through 2 others, likely due to mechanical stresses. See Figure 15 for low and high magnification microscopy images of 160143-7 (25T).

Figure 14. The as-received core 160143-7 (25T).

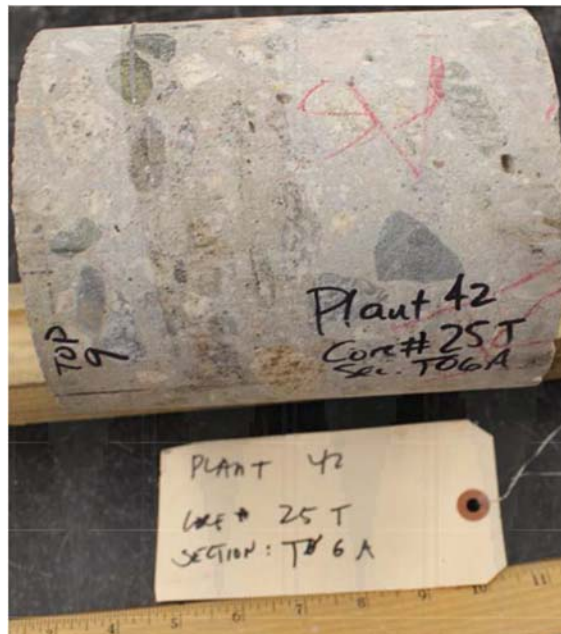
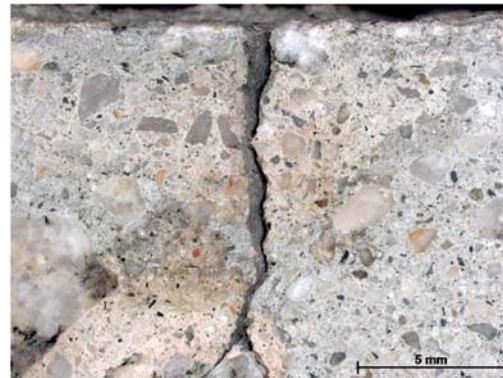


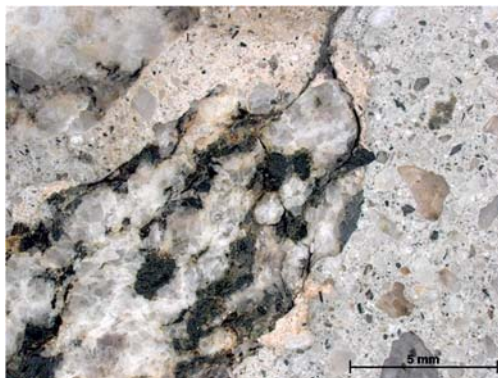
Figure 15. Low and High magnifications of 160143-7 (25T). (a) little to no carbination sataining at the surface, (b) carbination stainging at the surface following older crack, (c) carbination staining around cracked coarse aggregate, (d) high magnifiction to see fine aggregate and cement.



(a) Low magnification photomicrograph



(b) Low magnification photomicrograph



(c) Low magnification photomicrograph



(d) High magnification photomicrograph

3.8 Core Sample 160143-8 (28)

The as-received core 160143-8 (28) is shown in Figure 16. The core was 9.875 inches long and 6 inches in diameter. Minor carbonation staining within an inch of the surface was observed. There was no visible signs of ASR gel or damage due to ASR gel expansion. Voids were partially infilled with a white deposit, most likely ettringite and calcium hydroxide. A crack extended through the sample, greater than 0.5mm width, but sample remained intact. The crack did not extend through any aggregates except the edge of one at 3 in in depth. See Figure 17 for low and high magnification microscopy images of 160143-8 (28).

Figure 16. The as-received core 160143-8 (28).

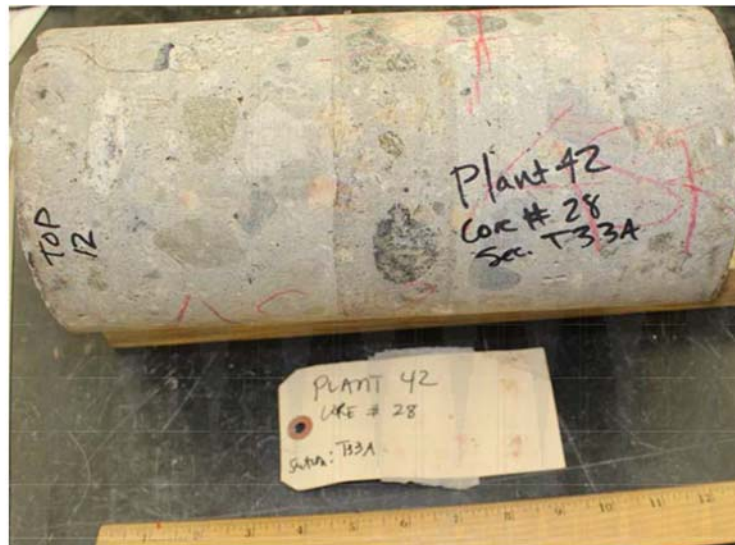
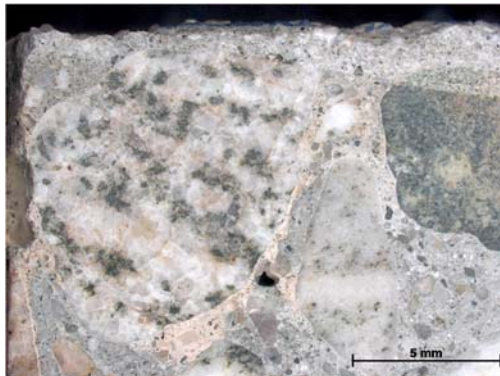
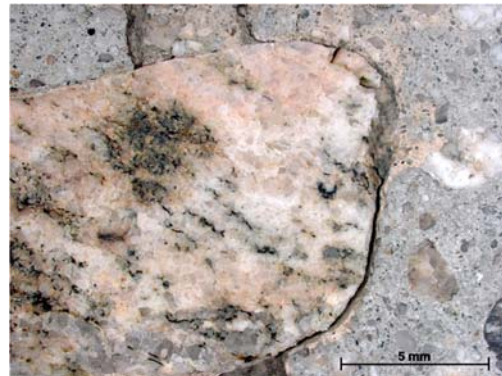


Figure 17. Low and High magnifications of 160143-8 (28). (a) minor carbination staining at the surface, (b) carbination staining following crack around coarse aggregate, (c) crack extending through coarse aggregate, (d) high magnification to see fine aggregate and cement.



(a) Low magnification photomicrograph



(b) Low magnification photomicrograph



(c) Low magnification photomicrograph



(d) High magnification photomicrograph

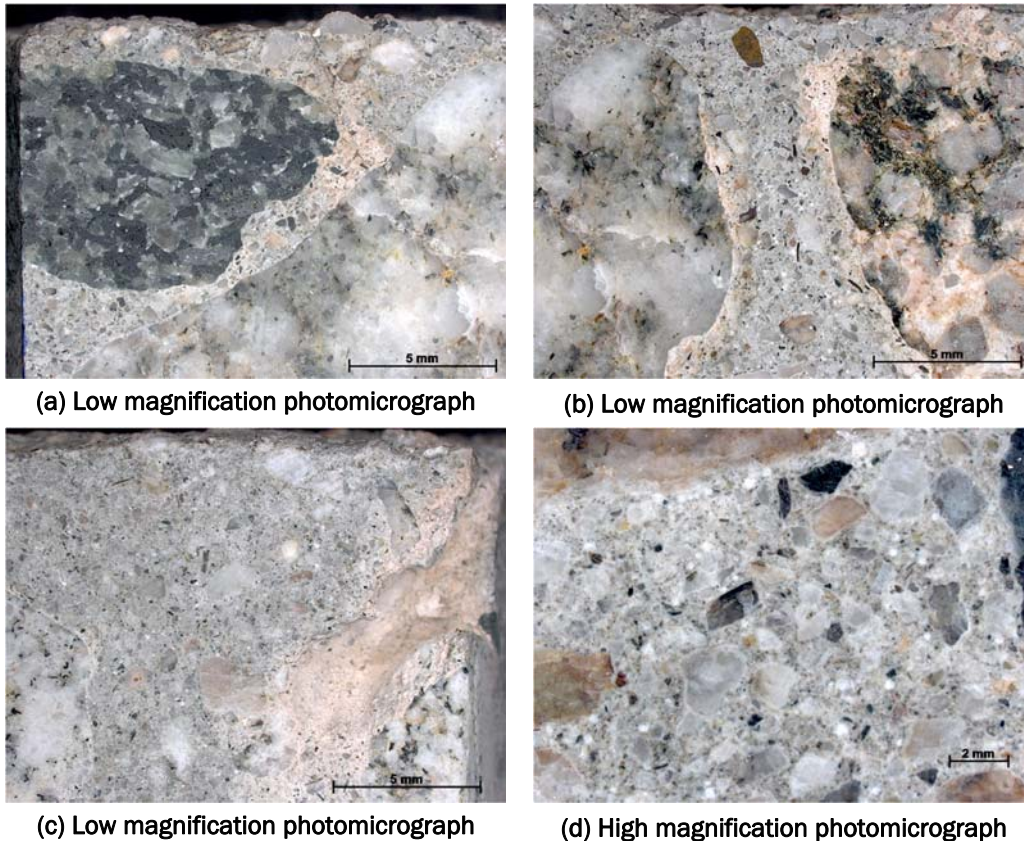
3.9 Core Sample 160143-9 (54T)

The as-received core 160143-9 (54T) is shown in Figure 18. The core was 6.75 inches long and 6 inches in diameter. Minor carbonation staining within an inch of the surface was observed. There was no visible signs of ASR gel or damage due to ASR gel expansion. Voids were partially infilled with a white deposit, most likely ettringite and calcium hydroxide. A crack at surface was 7mm deep and less than 0.1 mm in width, and terminates at a coarse aggregate. Coarse aggregate near the surface show signs of chemical weathering at grain boundaries within the aggregate, most likely due to wetting at the surface. Similar aggregates look like a gneiss and show no sign of weathering or chemical alteration with depth. See Figure 19 for low and high magnification microscopy images of 160143-9 (54T).

Figure 18. The as-received core 160143-9 (54T).



Figure 19. Low and High magnifications of 160143-9 (54T). (a) minor carbination sataining at the surface, (b) carbination stainging following coarse aggregate, (c) carbination staining in older void, (d) high magnifiction to see fine aggregate and cement.



3.10 Core Sample 160143-10 (56T)

The as-received core 160143-10 (56T) is shown in Figure 20. The core was 9.5 inches long and 6 inches in diameter. There was no visible signs of ASR gel or damage due to ASR gel expansion, and no visible staining due to carbonation. Voids were partially infilled with a white deposit, most likely ettringite and calcium hydroxide. Two cracks were observed, both 20mm deep and greater than 0.2mm width. See Figure 21 for low and high magnification microscopy images of 160143-10 (56T).

Figure 20. The as-received core 160143-10 (56T).

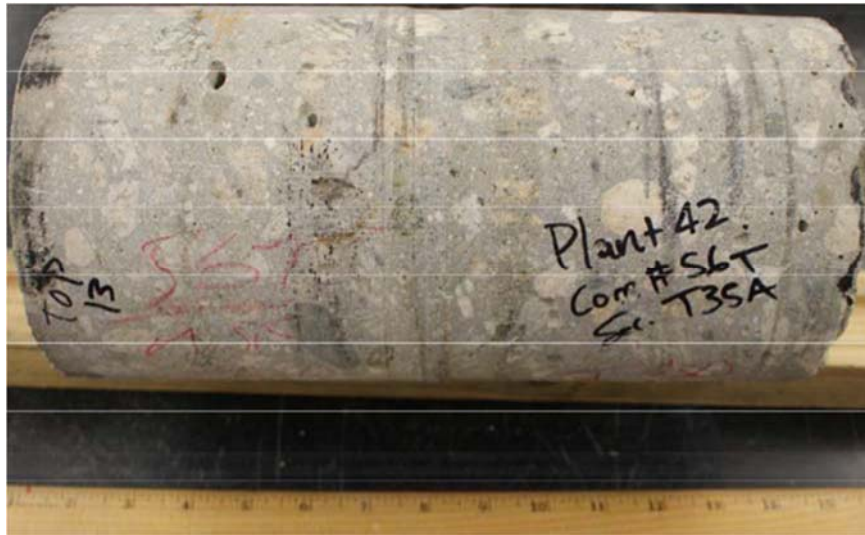
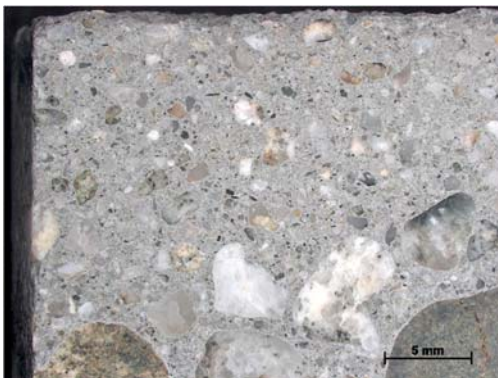


Figure 21. Low and High magnifications of 160143-10 (56T). (a) little to no carbonation staining at the surface, (b) cracks at the surface of the sample, (c) crack in coarse aggregate with iron staining, (d) high magnification to see fine aggregate and cement with cracking.



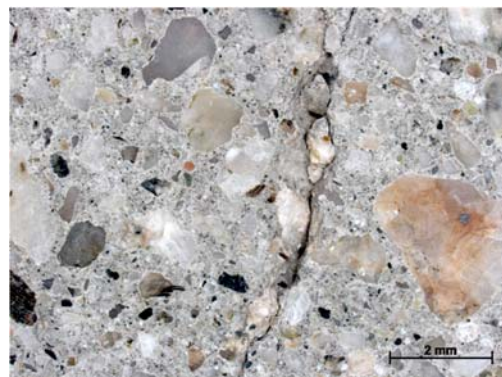
(a) Low magnification photomicrograph



(b) Low magnification photomicrograph



(c) Low magnification photomicrograph



(d) High magnification photomicrograph

3.11 Core Sample 160143-11 (78T)

The as-received core 160143-11 (78T) is shown in Figure 22. The core was 6.75 inches long and 6 inches in diameter. Minor carbonation staining within an inch of the surface was observed. There was no visible signs of ASR gel or damage due to ASR gel expansion. Voids were partially infilled with a white deposit, most likely ettringite and calcium hydroxide. A crack was observed that extends 15mm from the surface and was less than 0.1mm in width. See Figure 23 for low and high magnification microscopy images of 160143-11 (78T).

Figure 22. The as-received core 160143-11 (78T).

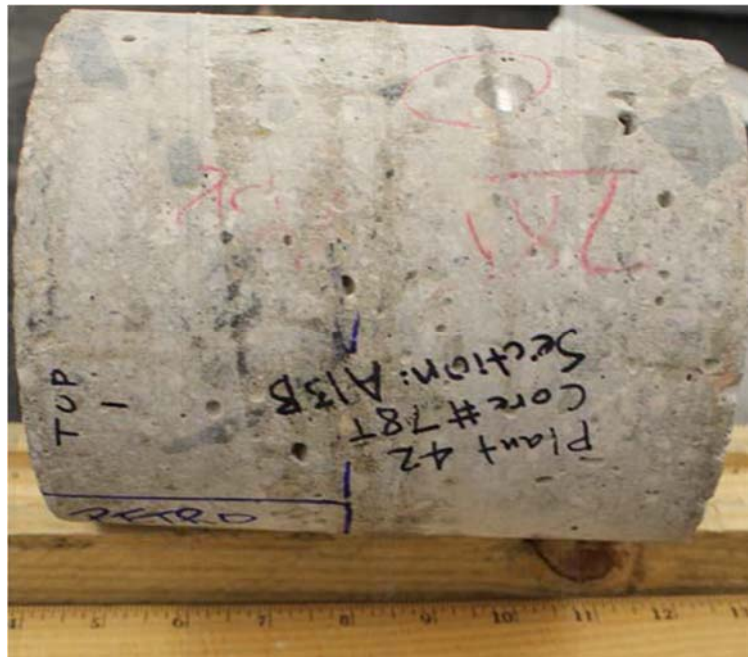
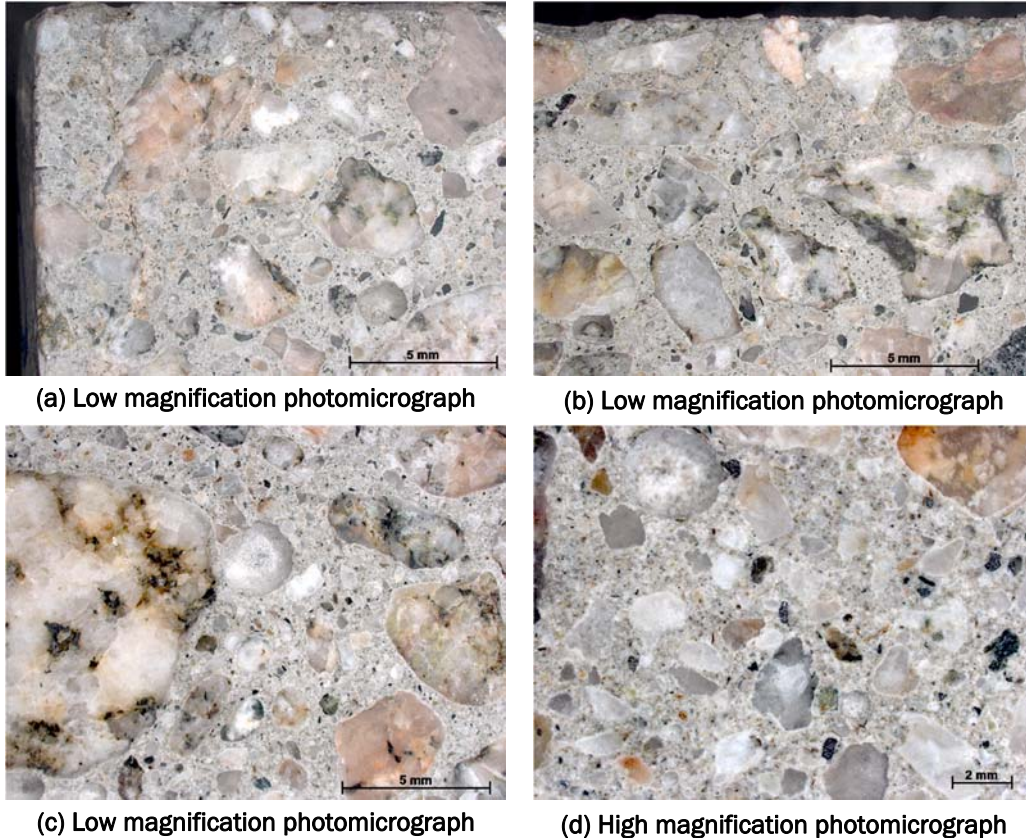


Figure 23. Low and High magnifications of 160143-10 (56T). (a) little to no carbonation staining at the surface, (b) little to no staining at the surface, (c) very little distress seen within the sample, (d) high magnification to see fine aggregate and cement.



3.12 Core Sample 160143-12 (120T)

The as-received core 160143-12 (120T) is shown in Figure 24. The core was 7.75 inches long and 6 inches in diameter. There was no visible carbonation staining observed. There was no visible signs of ASR gel or damage due to ASR gel expansion. Voids were partially infilled with a white deposit, most likely ettringite and calcium hydroxide. A crack was observed at the surface, extends 30mm into sample and was less than 0.1mm in width. See Figure 25 for low and high magnification microscopy images of 160143-12 (120T).

Figure 24. The as-received core 160143-12 (120T).

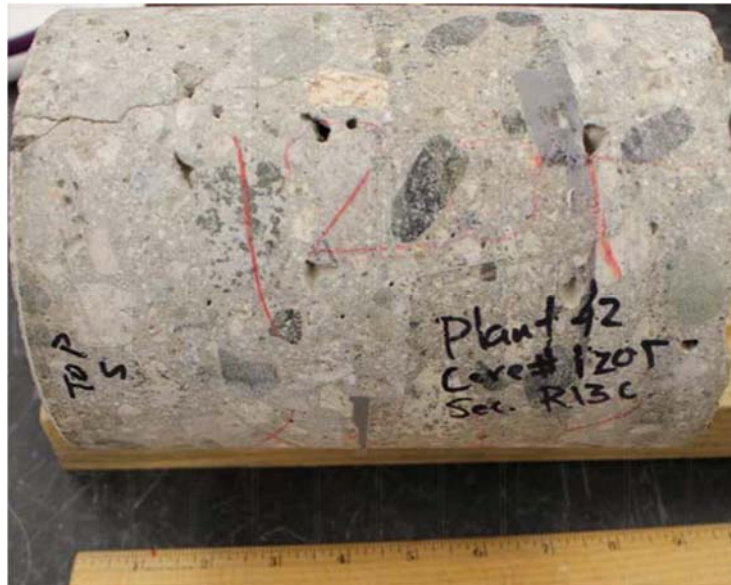


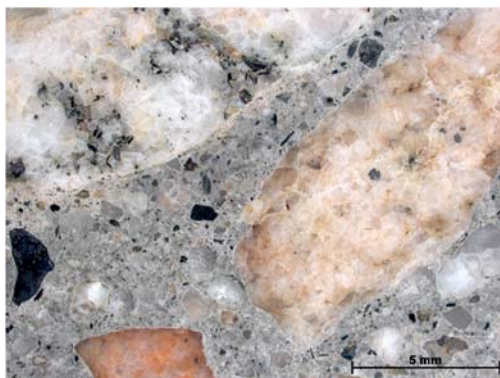
Figure 25. Low and High magnifications of 160143-12 (120T). (a) little to no carbination sataining at the surface, (b) fine crack at the surface of the sample, (c) minor staining around coarse aggregate, (d) high magnification to see fine aggregate and cement.



(a) Low magnification photomicrograph



(b) Low magnification photomicrograph



(c) Low magnification photomicrograph



(d) High magnification photomicrograph

3.13 Core Sample 160143-13 (123T)

The as-received core 160143-13 (123T) is shown in Figure 26. The core was 6.625 inches long and 6 inches in diameter. Carbonation staining was observed only around large entrapped air voids. Large entrained air voids have little to no deposits of ettringite or calcium hydroxide. There was no visible signs of ASR gel or damage due to ASR gel expansion. Two cracks were observed in the core. The first; a 3 mm crack, less than 0.2mm in width extends from the surface, terminates at a large entrapped air void (1/4" x 3/4"), reappears at a coarse aggregate boundary and extends into another entrained air void (1/8" x 1/4"). The second was a 15mm crack that was less than 0.1mm in width. See Figure 27 for low and high magnification microscopy images of 160143-13 (123T).

Figure 26. The as-received core 160143-13 (123T).

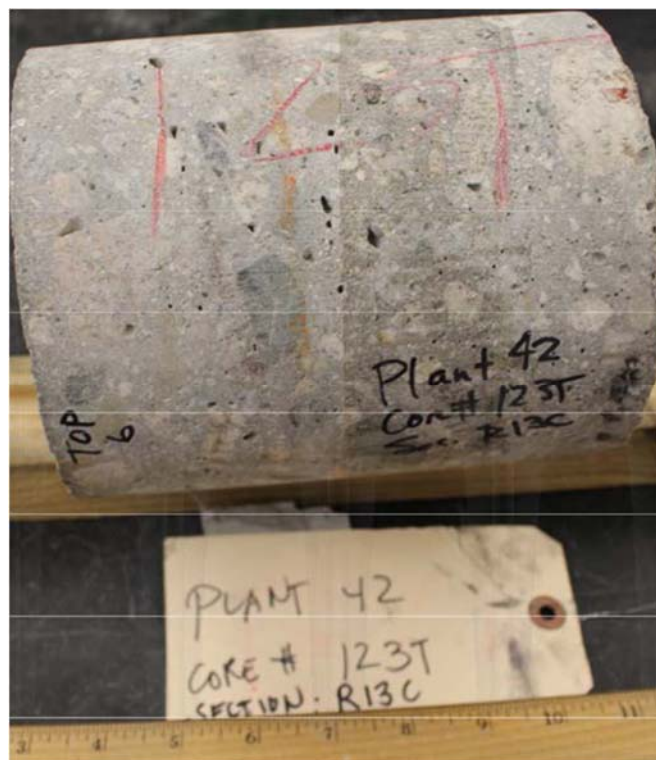
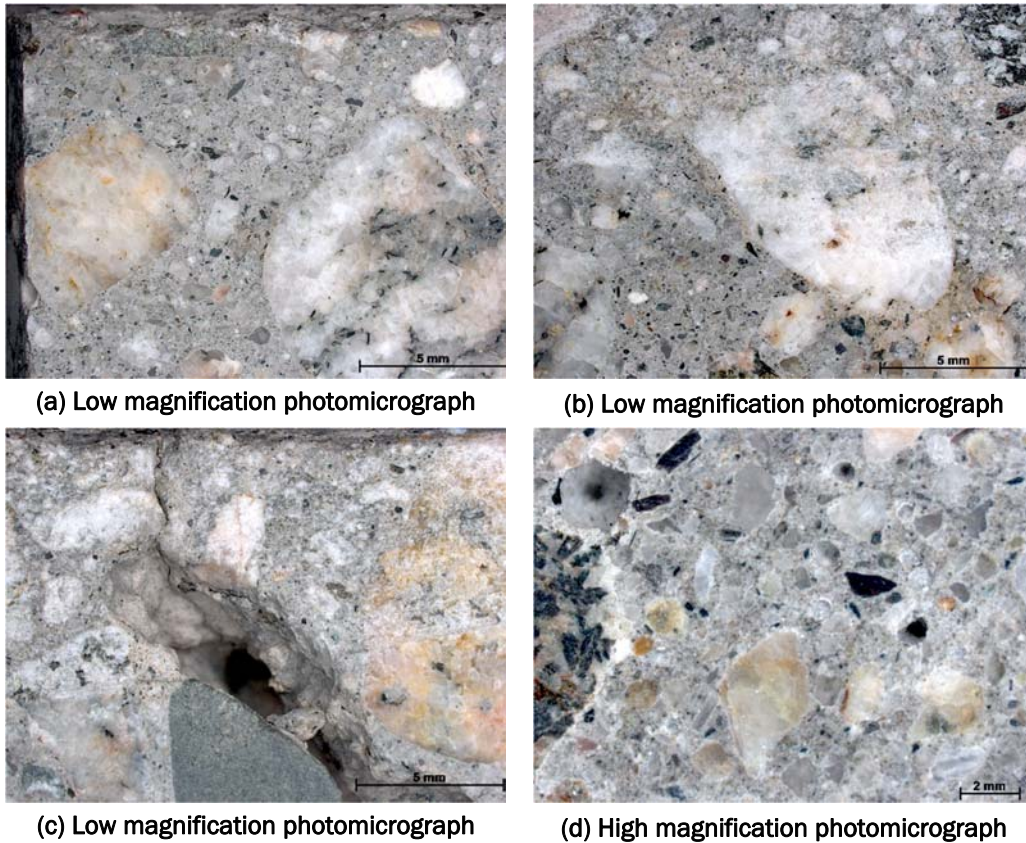


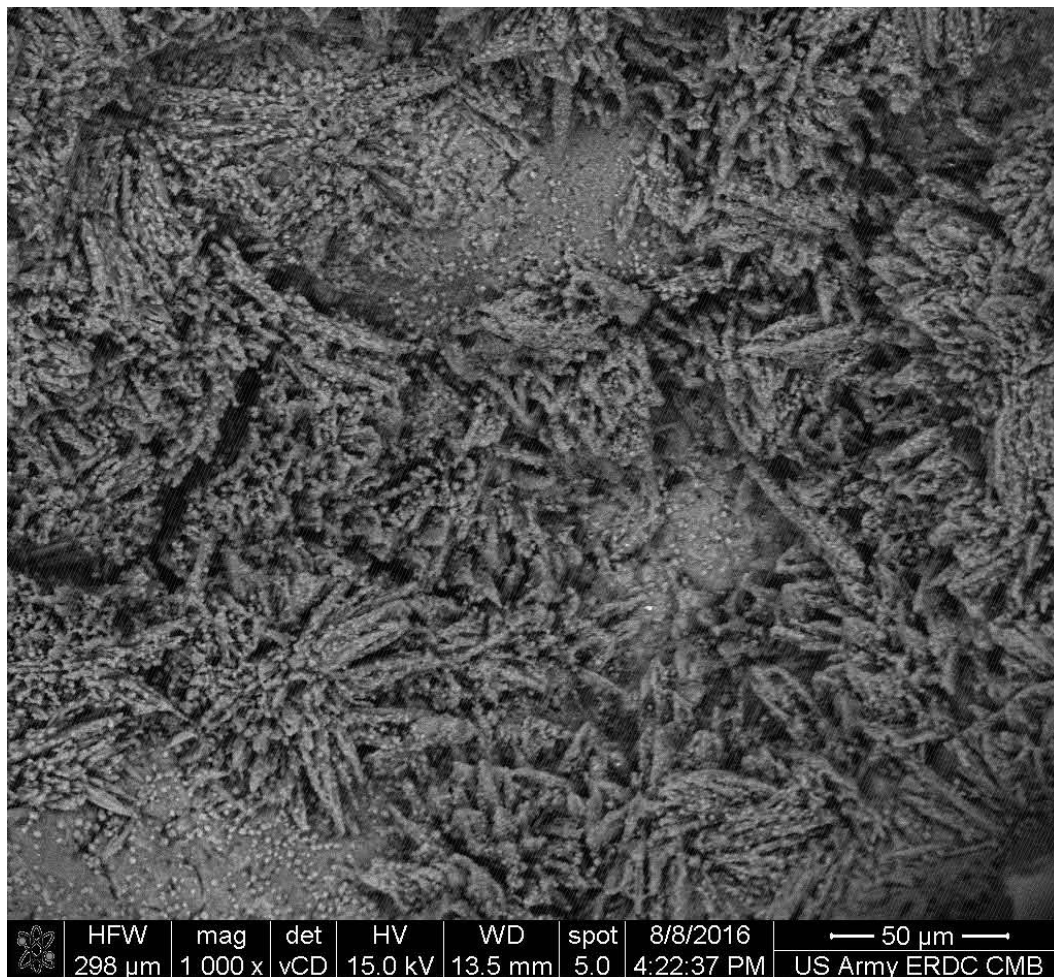
Figure 27. Low and High magnifications of 160143-13 (123T). (a) little to no carbination sataining at the surface, (b) minor staining around coarse aggregate, (c) cracking through large entrapped air void, with little to no staining, (d) high magnification to see fine aggregate and cement.



3.14 Scanning Electron Microscopy (SEM)

Core 160143-6 (13T) was evaluated in the SEM to determine the constituents of the white deposits that are found filling voids for most of the samples. In the image of a void, Figure 28, the radial needle-like crystals are ettringite and the smaller particles throughout the image are calcium hydroxide. If the deposits were ASR gel, there would be no crystal form and the gel would most likely be highly cracked.

Figure 28. SEM image of a void in core 160143-6 (13T). The radial needle-like crystals are ettringite, while the small particles are calcium hydroxide.



4 Summary and Conclusions

This study examined thirteen concrete cores provided to the ERDC by the US-AFCEC from Air Force Plant 42. The 13 cores, which were logged in as CMB No. 160143-1 to 160143-13, were subjected to an in-depth analysis consisting of visual and petrographic examination. The results of the study include were:

- Minor evidence of ASR was observed in 160143-5 (Core # 11T). Some of the microcracks appear to be infilled with gel.
- Staining was typically within an inch of the surface of each sample and due to carbonation.
- Air Void infilling is ettringite and calcium hydroxide.
- Summary of observed cracks according to crack width
 - # 11T, # 04T, # 08T, # 25T and # 28 (≥ 0.5 mm)
 - # 11T, # 56T, and # 123T (≥ 0.2 mm)
 - # 05T, # 13T, # 54T, # 78T, and # 120T (≤ 0.1 mm)

Most of the cracks appear to have been caused by mechanical stresses and/or shrinkage. There is little evidence of ASR induced issues. The presence of cracks larger than 0.2 mm can reduce the mechanical properties and durability of the concrete.


Contact Information

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Appendix A

DRILLING LOG			DIVISION	INSTALLATION		Hole No.	SHEET OF SHEETS
1. PROJECT				10. SIZE AND TYPE OF BIT			
2. LOCATION (Coordinates or Station)				11. DAYTIME FOR ELEVATION SHOWN (FROM SEA LEVEL)			
3. DRILLING AGENCY				12. MANUFACTURER'S DESIGNATION OF DRILL			
4. HOLE NO. (As shown on drawing title and file number)				13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN		DISTURBED UNDISTURBED	
5. NAME OF DRILLER				14. TOTAL NUMBER CORE BOXES			
6. DIRECTION OF HOLE <input type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED _____ DEG. FROM VERT.				15. ELEVATION GROUND WATER			
7. THICKNESS OF OVERBURDEN				16. DATE HOLE		STARTED COMPLETED	
8. DEPTH DRILLED INTO ROCK				17. ELEVATION TOP OF HOLE			
9. TOTAL DEPTH OF HOLE				18. TOTAL CORE RECOVERY FOR BORING			
				19. SIGNATURE OF INSPECTOR			
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVER- ERY	BOX OR SAMPLE NO.	REMARKS (Drilling runs, water level, depth of weathering, etc., if significant)	
a	b	c	d	e	f	g	
	5		Cracks w/ infilling of white gel				
			retro				
	10		B 1/2 in				
							

DIVISION			INSTALLATION			Hole No.	SHEET OF SHEETS
DRILLING LOG							
1. PROJECT AF			10. SIZE AND TYPE OF BIT				
2. LOCATION (Coordinates or Station) Hant 42			11. DAY/TIME FOR ELEVATION SHOWN (TSM or MSL)				
3. DRILLING AGENCY			12. MANUFACTURER'S DESIGNATION OF DRILL				
4. HOLE NO. (As shown on drawing title and file number) Core 04F			13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN		(DISTURBED)	(UNDISTURBED)	
5. NAME OF DRILLER Section ROSC			14. TOTAL NUMBER CORE BOXES		15. ELEVATION GROUND WATER		
6. DIRECTION OF HOLE <input type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED _____ DEG. FROM VERT.			16. DATE HOLE		STARTED	COMPLETED	
7. THICKNESS OF OVERBURDEN			17. ELEVATION TOP OF HOLE		18. TOTAL CORE RECOVERY FOR BORING		
8. DEPTH DRILLED INTO ROCK			19. SIGNATURE OF INSPECTOR		1		
9. TOTAL DEPTH OF HOLE							
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)	
a	b	c	d	e	f	g	
	5'		crack from top to back of core				
			Rebar				
			White gel piping				
			8 3/4"				
	11'						

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PROJECT _____ HOLE NO. _____


DRILLING LOG			DIVISION	INSTALLATION		SHEET OF SHEETS	
1. PROJECT				10. SIZE AND TYPE OF BIT			
2. LOCATION (Coordinates or Station)				11. DATUM FOR ELEVATION SHOWN (FSM or MSL)			
3. DRILLING AGENCY				12. MANUFACTURER'S DESIGNATION OF DRILL			
4. HOLE NO. (As shown on drawing title and file number)				13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN		DISTURBED UNDISTURBED	
5. NAME OF DRILLER				14. TOTAL NUMBER CORE BOXES			
6. DIRECTION OF HOLE <input type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED _____ DEG. FROM VERT.				15. ELEVATION GROUND WATER			
7. THICKNESS OF OVERBURDEN				16. DATE HOLE		STARTED COMPLETED	
8. DEPTH DRILLED INTO ROCK				17. ELEVATION TOP OF HOLE			
9. TOTAL DEPTH OF HOLE				18. TOTAL CORE RECOVERY FOR BORING			
				19. SIGNATURE OF INSPECTOR			
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Logging time, water level, depth of weather logs, etc., if sight record)	
a	b	c	d	e	f	g	

(Handwritten notes from image: Plant 42, 05T T03A, PLW, 9 3/4")

DRILLING LOG			DIVISION		INSTALLATION		Hole No.		SHEET OF SHEETS	
1. PROJECT					10. SIZE AND TYPE OF BIT					
2. LOCATION (Coordinates or Station)			Plant 42		11. DATUM FOR ELEVATION SHOWN (TBM or BM)					
3. DRILLING AGENCY					12. MANUFACTURER'S DESIGNATION OF DRILL					
4. HOLE NO. (As shown on drawing title and file number)			DBT		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN		DISTURBED		UNDISTURBED	
5. NAME OF DRILLER			K031		14. TOTAL NUMBER CORE BOXES					
6. DIRECTION OF HOLE <input type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED _____ DEG. FROM VERT.					15. ELEVATION GROUND WATER					
7. THICKNESS OF OVERBURDEN					16. DATE HOLE		STARTED		COMPLETED	
8. DEPTH DRILLED INTO ROCK					17. ELEVATION TOP OF HOLE					
9. TOTAL DEPTH OF HOLE					18. TOTAL CORE RECOVERY FOR BORING				%	
					19. SIGNATURE OF INSPECTOR					
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of reaction, etc., if a log is used)				
a	b	c	d	e	f	g				
			Rock through total length splits @ 9.5" intervals per foot							
	5									
	10		9.5"							

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PROJECT _____ HOLE NO. _____

DRILLING LOG			Hole No.			
DIVISION			INSTALLATION	SHEET OF SHEETS		
1. PROJECT			10. SIZE AND TYPE OF BIT			
2. LOCATION (Coordinates or Station)			11. DATUM FOR ELEVATION SHOWN (BSM or MSL)			
3. DRILLING AGENCY			12. MANUFACTURER'S DESIGNATION OF DRILL			
4. HOLE NO. (As shown on drawing title and log number)			13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN			
5. NAME OF DRILLER			14. TOTAL NUMBER CORE BOXES			
6. DIRECTION OF HOLE <input type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED _____ DEG. FROM VERT.			15. ELEVATION GROUND WATER			
7. THICKNESS OF OVERBURDEN			16. DATE HOLE			
8. DEPTH DRILLED INTO ROCK			17. ELEVATION TOP OF HOLE			
9. TOTAL DEPTH OF HOLE			18. TOTAL CORE RECOVERY FOR BORING			
			19. SIGNATURE OF INSPECTOR			
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Logging laws, water level, depth of weathering, etc., if right there) g
			vertical large cracks ↑ amount of gel @ rebar surface Δ 6.5"			
						

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PROJECT

HOLE NO.

DRILLING LOG			DIVISION	INSTALLATION		Hole No.	SHEET OF SHEETS
1. PROJECT <div style="font-size: 1.2em; margin-left: 100px;">CJ AF</div>			10. SIZE AND TYPE OF BIT		11. DAY ON FOR ELEVATION SHOWN (YBM or MSL)		
2. LOCATION (Coordinates or Station) <div style="margin-left: 100px;">Plant 42</div>			12. MANUFACTURER'S DESIGNATION OF DRILL				
3. DRILLING AGENCY			13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN		DISTURBED	UNDISTURBED	
4. HOLE NO. (As shown on drawing title and file number)			14. TOTAL NUMBER CORE BOXES		15. ELEVATION GROUND WATER		
5. NAME OF DRILLER <div style="margin-left: 100px;">Section: T1A</div>			16. DATE HOLE		STARTED	COMPLETED	
6. DIRECTION OF HOLE <input type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED _____ DEG. FROM VERT.			17. ELEVATION TOP OF HOLE		18. TOTAL CORE RECOVERY FOR BORING %		
7. THICKNESS OF OVERBURDEN			19. SIGNATURE OF INSPECTOR				
8. DEPTH DRILLED INTO ROCK							
9. TOTAL DEPTH OF HOLE							
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV- ERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water level, depth of weathering, etc., if significant) g	
<div style="position: absolute; right: -10px; top: 0; bottom: 0; width: 10px; border-right: 1px solid black; transform: rotate(90deg);"></div> <div style="position: absolute; left: 0; top: 0; bottom: 0; width: 10px; border-left: 1px solid black;"></div>	<div style="font-size: 1.5em; margin-bottom: 10px;">6'</div>	<div style="font-size: 1.2em; margin-top: 100px;">C 3/4"</div>	<div style="font-size: 1.2em; margin-top: 100px;">No visible cracking</div>	<div style="font-size: 1.2em; margin-top: 100px;">Petro</div>			

DRILLING LOG		DIVISION		INSTALLATION		Hole No.		SHEET OF SHEETS	
1. PROJECT		CS AF		10. SIZE AND TYPE OF BIT					
2. LOCATION (Coordinates or Station)		Plant 42		11. DATUM FOR ELEVATION SHOWN (TBM or MLL)					
3. DRILLING AGENCY				12. MANUFACTURER'S DESIGNATION OF DRILL					
4. HOLE NO. (As shown on drawing title and site number)		Core A 25T		13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN		DISTURBED		UNDISTURBED	
5. NAME OF DRILLER		Section: TOGA		14. TOTAL NUMBER CORE BOXES					
6. DIRECTION OF HOLE <input type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED _____ DEG. FROM VERT.				15. ELEVATION GROUND WATER					
7. THICKNESS OF OVERBURDEN				16. DATE HOLE		STARTED		COMPLETED	
8. DEPTH DRILLED INTO ROCK				17. ELEVATION TOP OF HOLE					
9. TOTAL DEPTH OF HOLE				18. TOTAL CORE RECOVERY FOR BORING		5			
19. SIGNATURE OF INSPECTOR									
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	SCORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water level, depth of weathering, etc., if applicable)			
a	b	c	d	e	f	g			
			Crack throughout - hole is cracked as well		Petro				
			7.5"						
									

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PROJECT _____ HOLE NO. _____

DRILLING LOG			DIVISION	INSTALLATION		Hole No.	SHEET OF SHEETS
1. PROJECT				10. SIZE AND TYPE OF BIT			
2. LOCATION (Coordinate or Station)				11. DAYTON FOR ELEVATION SHOWN (FSM or ASL)			
3. DRILLING AGENCY				12. MANUFACTURER'S DESIGNATION OF DRILL			
4. HOLE NO. (As shown on drawing title and file number)				13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN		DISTURBED	UNDISTURBED
5. NAME OF DRILLER				14. TOTAL NUMBER CORE BOXES			
6. DIRECTION OF HOLE <input type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED _____ DEG. FROM VERT.				15. ELEVATION GROUND WATER			
7. THICKNESS OF OVERBURDEN				16. DATE HOLE		STARTED	COMPLETED
8. DEPTH DRILLED INTO ROCK				17. ELEVATION TOP OF HOLE			
9. TOTAL DEPTH OF HOLE				18. TOTAL CORE RECOVERY FOR BORING			
				19. SIGNATURE OF INSPECTOR			
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water to bit, thickness weathering, etc., if applicable)	
a	b	c	d	e	f	g	
			No visible markings		Petro		
5			3 refert - 1 partial				
10			93%				

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PROJECT _____ HOLE NO. _____

DRILLING LOG			Hole No.			
DIVISION		INSTALLATION		SHEET OF SHEETS		
1. PROJECT <i>CJ AF</i>		10. SIZE AND TYPE OF BIT				
2. LOCATION (Coordinates or Station) <i>Plant 42</i>		11. DATUM FOR ELEVATION SHOWN (TBM or BGL)				
3. DRILLING AGENCY		12. MANUFACTURER'S DESIGNATION OF DRILL				
4. HOLE NO. (As shown on drawing title and file number) <i>Core # SAT</i>		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN				
5. NAME OF DRILLER <i>Section: TOTA</i>		14. TOTAL NUMBER CORE BOXES				
6. DIRECTION OF HOLE <input type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER				
7. THICKNESS OF OVERBURDEN		16. DATE HOLE <input type="checkbox"/> STARTED <input type="checkbox"/> COMPLETED				
8. DEPTH DRILLED INTO ROCK		17. ELEVATION TOP OF HOLE				
9. TOTAL DEPTH OF HOLE		18. TOTAL CORE RECOVERY FOR BORING <i>1</i>				
19. SIGNATURE OF INSPECTOR						
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if not listed)
a	b	c	d	e	f	g
			<i>No well cracking</i>			
					<i>Petro</i>	
	<i>5</i>		<i>6 3/4"</i>			

DRILLING LOG			DIVISION		INSTALLATION		SHEET OF SHEETS	
1. PROJECT <i>CJ AF</i>					10. SIZE AND TYPE OF BIT			
2. LOCATION (Coordinates or Station) <i>Plant 42</i>					11. DATUM FOR ELEVATION SHOWN (TBM or BENCH)			
3. DRILLING AGENCY					12. MANUFACTURER'S DESIGNATION OF DRILL			
4. HOLE NO. (As shown on drawing title and site number) <i>Cone # 56T</i>					13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN		DISTURBED <input type="checkbox"/> UNDISTURBED <input type="checkbox"/>	
5. NAME OF DRILLER <i>Section T35A</i>					14. TOTAL NUMBER CORE BOXES			
6. DIRECTION OF HOLE <input type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED _____ DEG. FROM VERT.					15. ELEVATION GROUND WATER			
7. THICKNESS OF OVERBURDEN					16. DATE HOLE		STARTED <input type="checkbox"/> COMPLETED <input type="checkbox"/>	
8. DEPTH DRILLED INTO ROCK					17. ELEVATION TOP OF HOLE			
9. TOTAL DEPTH OF HOLE					18. TOTAL CORE RECOVERY FOR BORING _____ %			
19. SIGNATURE OF INSPECTOR								
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)		
a	b	c	d	e	f	g		
	0		Visible cracking					
5	0		- Refer					
10			9.5"					

[illegible]

DRILLING LOG			DIVISION		INSTALLATION		Hole No.		SHEET OF SHEETS		
1. PROJECT			2. LOCATION (Coordinates for Station)		3. DRILLING AGENCY		4. HOLE NO. (As shown on drawing title and file number)		5. NAME OF DRILLER		
6. SIZE AND TYPE OF BIT			7. DATE FOR ELEVATION SHOWN (FPM or MSL)		8. MANUFACTURER'S DESIGNATION OF DRILL		9. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN		10. TOTAL NUMBER CORE BOXES		
11. DIRECTION OF HOLE <input type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED _____ DEG. FROM VERT.			12. ELEVATION TOP OF HOLE		13. ELEVATION GROUND WATER		14. DATE HOLE		15. SIGNATURE OF INSPECTOR		
16. THICKNESS OF OVERBURDEN			17. DEPTH DRILLED INTO ROCK		18. TOTAL CORE RECOVERY FOR BORING		19. TOTAL DEPTH OF HOLE		20. REMARKS		
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water level, depth of weathering, etc., if significant)					
a	b	c	d	e	f	g					
			Crack-throughout length No rebar w/gel								

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PROJECT

HOLE NO.

DRILLING LOG			DIVISION		INSTALLATION		Hole No.		SHEET OF SHEETS	
1. PROJECT			AF		10. SIZE AND TYPE OF BIT					
2. LOCATION (Coordinates or Station)			Part 42		11. DATUM FOR ELEVATION SHOWN (TBM or MSL)					
3. DRILLING AGENCY					12. MANUFACTURER'S DESIGNATION OF DRILL					
4. HOLE NO. (As shown on drawing title and site number)			1231		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN		DISTURBED		UNDISTURBED	
5. NAME OF DRILLER			RBC		14. TOTAL NUMBER CORE BOXES					
6. DIRECTION OF HOLE <input type="checkbox"/> VERTICAL <input type="checkbox"/> INCLINED _____ DEG. FROM VERT.					15. ELEVATION GROUND WATER					
7. THICKNESS OF OVERBURDEN					16. DATE HOLE		STARTED		COMPLETED	
8. DEPTH DRILLED INTO ROCK					17. ELEVATION TOP OF HOLE					
9. TOTAL DEPTH OF HOLE					18. TOTAL CORE RECOVERY FOR BORING				%	
					19. SIGNATURE OF INSPECTOR					
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Described)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water flow, depth of weathering, etc., if significant)				
a	b	c	d	e	f	g				
	5		No visible cracks white fill, large entrapped air voids							
	10		65%							

